CLAIMS

1. A method of LV-only fusion pacing therapy delivery to a non-synchronous pair of ventricles, comprising:

a) measuring an intrinsic P-R cardiac interval for a right ventricular (RV) chamber for at least one prior cardiac cycle;

b) decrementing the P-R interval to derive a nominal A-LVp interval;

c) delivering an LV-only pacing therapy using the nominal A-LVp interval and

d) determining whether adequate ventricular fusion resulted, and

in the event that adequate ventricular fusion resulted, then:

i) measuring a LEPARS interval by the amount of time elapsed between the delivery of the LV-only pacing therapy and a subsequent sensed depolarization of the RV; and

ii) delivering during a subsequent cardiac cycle at least one LV-only pacing therapy pulse to a left ventricular (LV) chamber, wherein said at least one LV-only pacing therapy pulse is delivered at the expiration of an A-LVp interval that preserves heart rate response requirements and substantially preserves the LEPARS interval; and

in the event that inadequate ventricular fusion failed to result, then:

modifying the A-LVp interval and repeating step c) through step d) above wherein the modified A-LVp interval is implemented in lieu of the nominal A-LVp interval.

2. A method according to claim 1, wherein the step of measuring an intrinsic P-R cardiac interval further comprises at least one of:

calculating an average P-R interval,

calculating a weighted average P-R interval,

measuring a prior intrinsic P-R interval,

looking up a P-R interval correlated to a heart rate,

looking up a P-R interval correlated to an activity sensor input,

looking up a P-R interval correlated to a minute ventilation value,

looking up a P-R interval correlated to a fluid pressure signal,

looking up a P-R interval correlated to a cardiac acceleration signal.

3. A method according to claim 1, further comprising:

attempting to detect a cardiac arrthymia episode; and

in the event the cardiac arrthymia is detected then either ceasing delivery of the LV-only fusion pacing or performing a mode switch to a different pacing modality.

4. A method according to claim 1, wherein said at least one LV-only pacing pulse is delivered via at least one electrode adapted to be coupled to a portion of the LV chamber.

5. A method according to claim 4, wherein the LV chamber comprises a portion of one of:

a coronary sinus,

a portion of a great vein,

a portion of a vessel branching from the great vein,

an inferolateral cardiac vein.

6. A method according to claim 1, wherein said at least one LV-only pacing therapy pulse is delivered between a first pacing electrode and a second pacing electrode, wherein said second pacing electrode comprises one of the group:

a ring pacing electrode, a pair of electrodes, a can-based electrode, a coil electrode, an epicardial electrode, a subcutaneous electrode, a surface electrode.

7. A method according to claim 1, wherein the step of measuring the LEPARS interval further comprises:

a tip and a ring pacing electrode pair configured to operatively couple to the free wall of the LV chamber for detecting the moment that LV-only pacing stimulation occurs and a pair of electrodes configured to operatively couple to the apex portion of the RV chamber to sense the depolarization of the RV chamber.

8. A method according to claim 7, wherein at least one of said electrode(s) is adapted to couple to an anterior portion of the free wall of the LV chamber.

9. A method according to claim 1, wherein said at least one LV-only pacing therapy pulse is delivered with at least one electrode adapted to couple epicardially to the LV chamber.

10. A method according to claim 1, wherein the subsequent cardiac cycle comprises an immediately subsequent cardiac cycle.

11. A method according to claim 1, wherein the at least one prior cardiac cycle comprises an immediately prior cardiac cycle.

12. A method according to claim 1, wherein the at least one prior cardiac cycle comprises at least three consecutive, immediately prior, cardiac cycles.

13. A method according to claim 12, wherein the most recent of the at least three consecutive, immediately prior, cardiac cycles is mathematically weighted more heavily than the other of said cardiac cycles.

14. A method according to claim 1, further comprising:

monitoring a physiologic cardiac parameter of a patient during delivery of the fusion-based cardiac pacing regimen.

15. A method according to claim 14, further comprising:

comparing the physiologic parameter to a threshold value; and

based on the results of the comparison, performing at least one of:

ceasing delivery of the fusion-based cardiac pacing regimen,

applying a bi-ventricular pacing regimen on a beat-by-beat basis.

16. A method according to claim 11, wherein the LEPARS interval comprises a discrete range of interval values.

17. A method according to claim 14, wherein the output signal comprises at least one of: a heart rate output signal, a cardiac pressure output signal, a minute ventilation output signal, an activity sensor output signal, an acceleration output signal.

18. A method according to claim 17, wherein the plurality of discrete intervals are stored as a data set and wherein each discrete interval of the data set corresponds to a magnitude of the output signal.

19. An apparatus for delivering LV-only fusion-pacing therapy to promote mechanical synchrony between a right ventricular (RV) chamber and a left ventricular (LV) chamber, comprising:

means for measuring an intrinsic atrio-ventricular delay interval for a right ventricular (RV) chamber for at least one prior cardiac cycle;

means for delivering during a subsequent cardiac cycle at least one pacing pulse to a LV chamber, wherein said at least pacing pulse is delivered at

the expiration of an A-LVp interval, and wherein the intrinsic atrio-ventricular (P-R) interval is greater than said A-LVp interval; and

means for measuring and substantially maintaining a LEPARS interval during said LV-only fusion-pacing therapy delivery over a range of different paced heart rates.

20. A method according to claim 19, wherein the means for measuring the intrinsic atrio-ventricular (P-R) interval further comprises at least one of the following:

means for calculating an average P-R interval,

means for calculating a weighted average P-R interval,

means for measuring a prior intrinsic P-R interval,

means for looking up an P-R interval correlated to a heart rate,

means for looking up an P-R interval correlated to an activity sensor input,

means for looking up an P-R interval correlated to a minute respiration value,

means for looking up an P-R interval correlated to a fluid pressure signal,

means for looking up an P-R interval correlated to an acceleration signal.

21. An apparatus according to claim 19, wherein the comprises a right ventricle.

22. An apparatus according to claim 19, wherein said at least one LV-only pacing therapy pulse is delivered via at least one electrode adapted to be coupled to a portion of the free wall of the LV chamber.

23. An apparatus according to claim 22, wherein the LV chamber comprises a portion of one of:

a coronary sinus,

a portion of a great cardiac vein,

a portion of a vessel branching from the great cardiac vein,

a portion of an inferolateral cardiac vein.

24. An apparatus according to claim 19, wherein said at least one LV-only pacing therapy pulse is delivered between:

a tip and a ring pacing electrode, a pair of electrodes, a coil and a can-based electrode, a pair of coil electrodes, an epicardial electrode and a second electrode, or a subcutaneous electrode and the second electrode.

25. An apparatus according to claim 19, wherein the means for measuring comprises at least one of:

a tip and a ring pacing electrode,

a pair of electrodes,

a coil and a can-based electrode,

a pair of coil electrodes,

an epicardial electrode and a second electrode,

a subcutaneous electrode and the second electrode.

26. An apparatus according to claim 25, wherein at least one of said electrode(s) is adapted to couple to an anterior portion of the left ventricle.

27. An apparatus according to claim 19, wherein said at least one LV-only pacing therapy pulse is delivered with at least one electrode adapted to couple epicardially to the second-to-depolarize ventricular chamber.

28. An apparatus according to claim 19, wherein the subsequent cardiac cycle comprises an immediately subsequent cardiac cycle.

29. An apparatus according to claim 19, wherein the at least one prior cardiac cycle comprises an immediately prior cardiac cycle.

30. An apparatus according to claim 19, wherein the at least one prior cardiac cycle comprises at least three consecutive, immediately prior, cardiac cycles.

31. An apparatus according to claim 30, wherein the most recent of the at least three consecutive, immediately prior, cardiac cycles is mathematically weighted more heavily than the other said cardiac cycles.

32. An apparatus according to claim 19, further comprising:

means for monitoring a physiologic cardiac parameter of a patient during delivery of the fusion-based cardiac pacing regimen.

33. An apparatus according to claim 32, further comprising:

means for comparing the physiologic parameter to a threshold value; and

at least one of:

a. means for ceasing delivery of the fusion-based cardiac pacing regimen,

b. means for applying a bi-ventricular pacing regimen on a beat-by-beat basis,

c. means for decrementing the A-LVp delay interval.

34. An apparatus according to claim 29, wherein the A-LVp interval comprises a discrete interval among a plurality of discrete intervals and said plurality of intervals are correlated to a heart rate, and further comprising:

means for monitoring the heart rate of a patient; and

means for delivering at least one ventricular pre-excitation pacing pulse at the expiration of the discrete interval and for maintaining the LEPARS interval.

35. An apparatus according to claim 34, wherein the heart rate comprises a range of heart rates.

36. An apparatus according to claim 35, wherein the plurality of discrete intervals are stored as a data set and wherein each discrete interval corresponds to a range of heart rates.

37. A computer readable medium for storing instructions for performing a method, said method comprising delivering bi-ventricular, fusion-pacing therapy to one of a non-synchronous pair of ventricles, to promote mechanical synchrony between an intrinsically first-to-depolarize ventricular chamber and an intrinsically second-to-depolarize, ventricular chamber, comprising:

instructions for measuring an intrinsic atrio-ventricular delay interval for a first-to-depolarize ventricular chamber for at least one prior cardiac cycle; and

instructions for delivering during a subsequent cardiac cycle at least one ventricular pre-excitation pacing pulse to a second-to-depolarize ventricular chamber, wherein said at least one ventricular pre-excitation pacing pulse is delivered at the expiration of a ventricular pre-excitation interval, and wherein the intrinsic atrio-ventricular delay interval is greater than said ventricular pre-excitation interval.

38. A medium according to claim 37, wherein the instructions for measuring the intrinsic atrio-ventricular (AV) delay interval further comprises at least one of the following:

instructions for calculating an average AV delay interval,

instructions for calculating a weighted average AV delay,

instructions for measuring a prior intrinsic AV delay interval,

instructions for looking up an AV delay interval correlated to a heart rate,

instructions for looking up an AV delay interval correlated to an activity sensor input,

instructions for looking up an AV delay interval correlated to a minute respiration value,

instructions for looking up an AV delay interval correlated to a fluid pressure signal,

instructions for looking up an AV delay interval correlated to an acceleration signal.

39. A medium according to claim 37, wherein the first-to-depolarize ventricular chamber comprises a right ventricle.

40. A medium according to claim 37, wherein said at least one ventricular pre-excitation pacing pulse is delivered via at least one electrode adapted to be coupled to a left ventricular chamber.

41. A medium according to claim 40, wherein the left ventricular chamber comprises a portion of one of:

a coronary sinus,

a portion of a great vein,

a portion of a vessel branching from the great vein.

42. A medium according to claim 37, wherein said at least one ventricular pre-excitation pacing pulse is delivered between:

a tip and a ring pacing electrode, a pair of electrodes, a coil and a can-based electrode, a pair of coil electrodes, an epicardial electrode and a second electrode, or a subcutaneous electrode and the second electrode.

43. A medium according to claim 37, wherein the instructions for measuring comprises at least one of:

a tip and a ring pacing electrode,

a pair of electrodes,

a coil and a can-based electrode,

a pair of coil electrodes,

an epicardial electrode and a second electrode,

a subcutaneous electrode and the second electrode.

44. A medium according to claim 43, wherein at least one of said electrode(s) is adapted to couple to an anterior portion of the left ventricle.

45. A medium according to claim 37, wherein said at least one ventricular pre-excitation pacing pulse is delivered with at least one electrode adapted to couple epicardially to the second-to-depolarize ventricular chamber.

46. A medium according to claim 37, wherein the subsequent cardiac cycle comprises an immediately subsequent cardiac cycle.

47. A medium according to claim 37, wherein the at least one prior cardiac cycle comprises an immediately prior cardiac cycle.

48. A medium according to claim 37, wherein the at least one prior cardiac cycle comprises at least three consecutive, immediately prior, cardiac cycles.

49. A medium according to claim 48, wherein the most recent of the at least three consecutive, immediately prior, cardiac cycles is mathematically weighted more heavily than the other said cardiac cycles.

50. A medium according to claim 37, further comprising:

instructions for monitoring a physiologic cardiac parameter of a patient during delivery of the fusion-based cardiac pacing regimen.

51. A medium according to claim 50, further comprising:

instructions for comparing the physiologic parameter to a threshold value; and at least one of:

a. instructions for ceasing delivery of the fusion-based cardiac pacing regimen,

b. instructions for applying a bi-ventricular pacing regimen on a beat-by-beat basis,

c. instructions for decrementing the pre-excitation interval.